

Map Unit Properties Table

Age	Unit Name (Symbol)	Features and Description	Location	Depositional Setting and Significance	Hazard Potential	Development and Resource Potential
Quaternary	Artificial fill (af)	Includes compacted and uncompacted material, mostly of silt, sand, and rock fragments; < 33 ft (10 m) thick; beneath Rim Rock Drive >164 ft (50 m)	Beneath segments of Rim Rock Drive and reservoir in lower Fruita Canyon			
	Alluvium (Qal)	Chiefly of stream- channel deposits including minor undifferentiated colluvial deposits; includes boulders as large as 6.6 ft (2 m) in diameter; exposed thickness about 3.3 to 13 ft (1 to 4 m)	Along tributary streams of the Colorado River	Streams, alluvial fans, debris flows, and sheetwash	Associated with flash floods; low- lying areas prone to periodic flooding and debris-flow deposition	
	Flood- plain and stream channel deposits (Qfp)	Clast- supported, slightly bouldery, pebble and cobble gravel in a sand matrix; thickness may locally exceed 23 ft (7 m)	Not in monument; deposited along the Colorado River		In low- lying areas, subject to flooding	Nearby gravel operations
	River- gravel deposits (Qrg)	Chiefly clast- supported, bouldery, cobble and pebble gravel in a sand matrix; clasts generally < 20 in (50 cm) in diameter, sub- rounded to well- rounded, and poorly to moderately sorted; scour- and- fill structures; imbricate clast fabric consistent with the W flow direction of the Colorado River; clasts include the diagnostic moderate- red Maroon Formation and the yellowish- gray Green River Formation among other rock types typical of those transported by Colorado River; thickness 3.3–13 ft (1–4 m)	Outside monument; hilltops on the S side of Colorado River	Indicates erosional history of Colorado River and climate history of the region		
	Local gravel deposits (Qlg)	Poorly sorted, sub- rounded, clast- and matrix- supported pebble and cobble gravel that locally contains boulders as large as 6.6 ft (2 m); clasts consist primarily of metamorphic and igneous Proterozoic rocks and secondarily of sedimentary rocks eroded from the adjacent highlands in the Uncompahgre Plateau; locally fills channels as deep as 3.3 ft (1 m) that are cut in the underlying bedrock; thickness as much as 20 ft (6 m)	Hilltops in the Redlands area	Deposited at different times between about 42,000 and 480,000 years ago by tributary streams of the Colorado River, probably includes both stream alluvium and debris- flow deposits		
	Colluvium, undivided (Qc)	Colluvium reflects bedrock and surficial units from which derived; clast- supported pebble, cobble, and boulder gravel with matrix of silty sand, minor clayey silt, and locally, gravelly silt derived from steep slopes; clasts angular to sub- angular and as large as 6.6 ft (2 m) in diameter; max. ~16 ft (5 m) thick	Along the steeper slopes of mountain front	Sheetwash, debris flows, and landslides	Associated with rockfall deposits (Qr) at base of cliffs of Wingate Sandstone (Jwg)	Colluvium from Morrison Formation contains expansive clays; colluvium from Chinle Formation (TRc) is silty and non-expansive
	Rockfall deposits (Qr)	Include boulders and smaller debris deposited on slopes; clasts typically 3.3–6.6 ft (1–2 m) in diameter, some exceed 39 ft (12 m); clasts on younger rockfall deposits unweathered with light bedrock colors; clasts on older rockfall deposits weathered and coated with a brownish- gray to brownish- black desert varnish; thickness 3.3 ft (1 m) to > 9.8 ft (3 m)	Along Rim Rock Drive	At base of cliffs, particularly of Wingate Sandstone (Jwg)	Concern for visitor safety where Rim Rock Drive and overlooks were built in areas of Qr	
	Younger landslide deposits (Qlsy)	Mostly intact, active, or recently active earth- block slides, commonly have crescentic headwall scarps; sizes and rock types of the clasts and the grain- size distributions and colors of the matrices reflect those of the displaced bedrock units and surficial deposits; thickness 26 ft (8 m)–115 ft (35 m)	Not in monument; formed where S side of Colorado River locally cut steep slopes on uppermost Dakota Formation (Kd) and lowermost Mancos Shale (Km)	Prone to continued movement; poses a hazard to roads or structures built on bluffs close to the river	Toes of landslides are being removed by Colorado River	
	Older landslide deposits (Qlso)	Chiefly unsorted and unstratified rock debris characterized by hummocky topography; often complex including debris from the Brushy Basin Member (Jmb), the Burro Canyon Formation (Kb), and the Dakota Formation (Kd); sizes and rock types of the clasts and the grain- size distributions and colors of the matrices reflect those of the displaced bedrock units and surficial deposits; contain blocks as large as 20 ft (6 m)	Particularly abundant on the slopes of Black Ridge	Formed on unstable slopes underlain by the Brushy Basin Member of the Morrison Formation (Jmb)	Prone to continued movement or reactivation; contains expansive smectitic clay and locally has high shrink- swell potential	Housing or other development on this unit may encounter landslide hazards
	Sheetwash deposits (Qsw)	Chiefly of light- gray sandy and silty clay on very gentle slopes with gradient of ~ 9.8 to 13 ft per .62 miles (3 to 4 m/km) N of the Colorado River where derived by erosion of the Mancos Shale (Km); 9.8–26 ft thick (3–8 m) close to the river, nearly 49 ft (15 m) thick at NE corner of map area	Grand Valley		Commonly vertical desiccation cracks partly filled with clay	Contains expansive clays that may cause stability problems for roads and buildings
	Eolian sand (Qe)	Silty, very fine to fine wind- blown sand; commonly massive to weakly bedded and lacks eolian sedimentary structures, which may have been obliterated by biotic processes; sand derived chiefly from weathering of poorly cemented Slick Rock Member (Jes) and “board beds” unit (Jeb) of the Entrada and Wingate Sandstones (Jwg); lesser amounts derived from sandstone members of the Morrison Formation (Jmt, Jms, and Jmb);, subject to redeposition as sheetwash on slopes; thickness about 26 ft (8 m)	Blankets upland areas of the Uncompahgre Plateau	Several climbing dunes are banked against bedrock and are as thick as 16 ft (5 m)		Structures built on unit commonly sustain minor damage from settling related hydrocompaction

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Quaternary	Eolian sand and sheetwash deposits (Qse)	Similar to Qe but contains more abundant clasts; consist chiefly of silty, very fine to fine sand commonly containing scattered granule- to cobble- size fragments from bedrock units exposed upslope, esp. between mountain front and Colorado River; contain discontinuous layers and lenses of poorly sorted clasts; thickness about 16 ft (5 m)	Mantles level to gently sloping surfaces, and silt, sand, and rock fragments on valley sides and hill slopes				
	Cienaga deposits (Qcg)	Silty sand, chiefly of eolian or sheetwash origin, deposited in marshy areas; where water table is at or near the surface, evaporation leaves precipitate of alkali crust a few inches thick, white, mostly devoid of vegetation; thickness 3.3 to 9.8 ft (1 to 3 m),	Marshy places in the Redlands area	Fed by seeps, generally well vegetated, upstream from constrictions of resistant beds of the Burro Canyon Formation (Kb) and the Dakota Formation (Kd)		Low bearing capacity and poses hazard to roads and structures built on it	
Cretaceous	Mancos Shale (Km)	Chiefly medium dark- gray, dark- gray, brownish- gray, and brownish- black fissile shale that weathers to light gray and forms gentle slopes; thickness > 4,495 ft (1,370 m) in W Colorado but < 66 ft (20 m) of lowermost Mancos is exposed south of the Colorado River in the map area	Only lowermost Mancos Shale exposed along the N boundary of the map area near the Colorado River	Lowermost stratum deposited in a shallow marine sub- tidal setting		Sedimentary structures (e.g., ripple marks and cross laminations) and fossils (e.g., trace fossil burrows and pelecypods and cephalopods)	
	Dakota Formation (Kd)	20 to 50% sandstone, 5 to 20% conglomerate, 40 to 60% mudstone, and < 5% impure coal; four parts (from top to bottom): interbedded sandstone and shale part, sandstone part, mudstone part, and conglomeratic part; upper part transitional with Mancos Shale (Km); thickness at Black Ridge about 102 ft (31 m) where uppermost part of unit has been removed by erosion; total unit thickness estimated at 148 to 164 ft (45 to 50 m)	Caps Black Ridge and forms a series of low hogbacks in the Redlands area	Sandstone and mudstone deposited in estuaries, tidal channels, distributary channels, bays, lagoons, strandlines, and barrier islands		Sandstone and conglomerate form prominent and resistant ledges and ridges; mudstone and interbedded sandstone and shale form slopes; bioturbation common throughout, includes plant roots and burrows; dinosaur tracks preserved in sandstone beds in Redlands area	
	Burro Canyon Formation (Kb)	40 to 80% mudstone, 20 to 60% sandstone, and 0 to 15% conglomerate; usually upper part dominated by mudstone and forms slopes; lower third to two- thirds dominated by sandstone and forms cliffs; thickness 96 ft (29.3 m) at Black Ridge	Saddle on Black Ridge	Flood plain and lacustrine		Sandstone includes large amounts of petrified wood; conglomerate clasts are mostly chert and quartz pebbles but include minor petrified wood and dinosaur bone	
Jurassic	Brushy Basin Member (Jmb)	85 to 95% mudstone, 5 to 15% sandstone, with trace of limestone; multicolored mudstone forms gentle rounded slopes; thicker channel (sandstone) sequences commonly have small- scale trough cross- stratification and scour surfaces accentuated by basal layers of pebble- size mud chips and granules of chert and quartz; thinner sandstone beds are commonly bioturbated; about 312 ft (95 m) thick	Morrison Formation consists of three members: <u>Brushy Basin Member</u> (slope- forming upper member), <u>Salt Wash Member</u> (cliff- forming middle member), and <u>Tidwell Member</u> (slope- forming lower member); total thickness about 525 ft (160 m)	In the vicinity of Black Ridge and Monument Mesa	Mud flat to saline lacustrine setting that was locally invaded by highly sinuous fluvial channels	Susceptible to mass wasting, particularly landsliding; bentonitic mudstone expands and dries to form a popcorn- like weathered surface	Contains barite nodules and dinosaur bones; commonly bioturbated
	Salt Wash Member (Jms)	30 to 80% sandstone, 20 to 70% mudstone, and traces of limestone; exhibits considerable lateral variation in thickness and rock type; thickness 102 ft (31 m) at Artists Point; within the sandstone portion, thicker sand bodies (up to 16 ft [5 m]) commonly exhibit small- to large- scale trough, tabular- tangential and sigmoidal cross- bedding, and scour surfaces		Road cuts on Rim Rock Drive S of Highland View Overlook	Fluvial setting and associated flood plains and shallow ponds	Salt Wash- Brushy Basin contact commonly obscured because of mass wasting	Elongate, narrow burrows are common near the tops of the thicker sand bodies; mudstone intervals commonly bioturbated by insect burrows and plant roots and are slightly fossiliferous, containing ostracodes and charophytes
	Tidwell Member (Jmt)	Laterally variable proportions of multi- colored, interbedded mudstone, 50 to 70%; sandstone, 10 to 40%; limestone, 5 to 20%; forms slopes broken by relatively thin ledges of sandstone and limestone; about 125 ft (38 m) thick at Artists Point		In road cuts along Rim Rock Drive between Artists Point and Highland View Overlook	Deposited in several environments: (1) fresh to brackish- water lacustrine setting, (2) beaches in lake- margin settings, and (3) fluvial and distributary channel systems		Mottled and bioturbated (burrows) limestone; stromatolitic lamination (algal [cyanobacteria?] growth); oncrites (algal biscuits); sparse fossils: ostracodes, charophytes, and very small gastropods
	Wanakah Formation	80 to 90% interstratified mudstone, 5 to 15% sandstone and silty sandstone, 0% to 5% impure limestone, with traces of volcanic ash and gypsum; slope- forming; recognized by distinctive green- over- red colors and by a noticeable reduction of vegetation; thickness 31 ft (9.4 m) thick at Artists Point	Entire formation exposed at Artists Point	Non- marine mud flat or shallow lacustrine environment		Bioturbation (burrows and roots); nodules (< 2 in [5 cm] in diameter) in limestone	

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Jurassic	Entrada Sandstone	“Board beds” unit (Jeb)	60–70% interbedded sandstone and 30–40% mudstone; interbedded resistant sandstone and less resistant mudstone form slabby exposures that resemble stack of boards; thickness about 43 ft (13 m) along Upper Monument Canyon Trail	Entrada Sandstone consists of two parts: “boards beds” (prominent white cap) and Slick Rock Member (conspicuous pale- orange, ribbon- like cliffs)	In road cuts along Rim Rock Drive between Artists Point and Coke Ovens Overlook	Coastal setting—wet sand flat	SW of No Thoroughfare Canyon sandstone beds locally contain gray petroleum residue (dead oil)
		Slick Rock Member (Jes)	Consists almost entirely (99%) of cross- bedded sandstone; weathers to form rounded benches or cliffs that are almost totally free of vegetation; thickness 112 ft (34 m) along Upper Monument Canyon Trail		Isolated hill by the N side of Rim Rock Drive about 131 ft (400 m) W of Red Canyon Overlook	Coastal eolian setting—dunes and wet sand flats (interdune areas)	
	Kayenta Formation (Jk)	80 to 90% sandstone (throughout), 0 to 10% conglomerate (mainly in upper half), and 0 to 10% mudstone (mainly in upper half); commonly forms resistant caps or ledges; thickness about 77 ft (23.5 m) along Upper Monument Canyon Trail	Rim Rock Drive follows Kayenta Formation ledges in many areas; well exposed in road cuts S of headquarters and above tunnels	High- energy braided- river systems; sediment transport to the W- NW			
	Wingate Sandstone (Jwg)	Consists of about 95% sandstone and about 5% mudstone; typically forms high, reddish- orange cliffs and monuments; thickness 328 ft (100 m) along Upper Monument Canyon Trail	From W entrance, in road cuts between Chinle Formation (TRc) and the tunnels	NE margin of a large dune area (erg); series of dune complexes (draas) and wet sand flats fluctuating in size and shape in accordance with climatic variations			
Triassic	Chinle Formation (TRc)	Interbedded 80 to 90% mudstone, 0 to 10% sandstone, 0 to 5% sandy conglomerate, and 0 to 5% limestone; forms distinctive red slopes; thickness 89 ft (27 m) along Upper Monument Canyon Trail	Exposures in the road cut in Fruita Canyon	Densely vegetated flood plain or mud flat containing localized shallow ponds and small, shallow, sinuous streams; water-table fluctuations common during deposition		Carbonate nodules (rhizocreations?), root traces, and burrows (crayfish?) common in mudstone portion; some limestone beds have stromatolitic (algal?) structures	
Precambrian	Lamprophyte dikes (YI)	Slightly altered, thin, dark- greenish- gray to greenish- black dikes; contain phenocrysts of biotite, hornblende, and pyroxene in a fine- grained matrix; subparallel and dip to the SE at 50° to 73°; thickness 6.6–9.8 ft (2–3 m)	NE part of No Thoroughfare Canyon and at the junction of Red and Columbus Canyons	About 1,400 million years old			
	Meta-igneous gneiss (Xi)	Biotite- bearing granitic rock with weak foliation and locally containing large feldspar phenocrysts	Exposed chiefly in E part of Ute Canyon	About 1,721 ± 14 million years ago			
	Migmatitic meta-sedimentary rocks (Xm)	Chiefly a mixture of schist and migmatitic pegmatite	N or E entrances to Monument Canyon; the freshest exposures are in the deepest drainages off the trails	1,741 ± 11 million years old (preliminary date)—probably age of metamorphism, not age of old rocks that eroded to produce sediments			